

impacts in Nevada of moving spent nuclear fuel and high-level radioactive waste to the site using 10 implementing alternatives. These included five potential corridors for a new branch rail line (see Section 2.1.3.3.2) and five potential combinations of intermodal transfer stations and highway routes for heavy-haul trucks (see Section 2.1.3.3.3).

Tables 2-10 and 2-11 compare the impacts from transportation activities in potential Nevada rail corridors and heavy-haul truck corridors, respectively, and includes the mostly legal-weight truck scenario impacts that would occur in Nevada. In addition, they list the distance of each route. The results include the potential corridor variations in the routes chosen, construction required, and operations. The impacts summarized in Tables 2-10 and 2-11 are based on the impact analyses in Chapter 6, Sections 6.3.1, 6.3.2, and 6.3.3, which delineate the corridor variations. Additional attributes such as cost, institutional acceptability of the route, construction and schedule risk, and operational compatibility could affect a decision on the choice of a transportation mode or route in Nevada.

The following conclusions can be drawn from the information in Tables 2-10 and 2-11:

- Environmental impacts for each of the 10 implementing alternatives would be small.
- With the exception of *collective dose*, the environmental impacts for shipment by legal-weight truck in Nevada would be smaller than those from the 10 implementing alternatives associated with incoming shipments by mostly rail scenario. However, even for shipment by legal-weight truck in Nevada, the projected collective dose impacts would be small (approximately 0.9 latent cancer fatality to both the public and transportation workers) over 24 years.
- With the exception of land use, differences in environmental impacts for the 10 implementing alternatives related to incoming shipments by mostly rail scenario would be small, so environmental impacts do not appear to be a major factor in the selection of transportation mode, route, or corridor in Nevada for incoming rail shipments.
- As much as about 20 square kilometers (4,900 acres) of land would be disturbed for new transportation routes. Three of the rail corridors would encroach on the western and southern boundaries of the Nellis Air Force Range. Of these three, one short segment of the Valley Modified Corridor would not have a variation that could avoid the encroachment. The Caliente-Chalk Mountain Corridor and the Caliente/Chalk Mountain heavy-haul truck route would travel directly through the range. The U.S. Air Force has stated that any route through the Range would have national security implications. Several rail corridors pass through or near Wilderness Study Areas or the proposed Ivanpah Valley Airport. Rail or heavy-haul truck routes could affect the Timbisha Shoshone trust lands, Las Vegas Paiute Reservation, or Moapa Reservation. Some routes could overlap predicted Las Vegas-area growth. Heavy-haul trucks would slow traffic flow.
- Impacts to cultural resources for any of the potential implementing alternative routes or corridors cannot be fully assessed until more detailed archaeological and ethnographic studies are conducted, but they are likely to be similar to one another. Impacts to Native American values could occur from the use of any of the routes including the use by legal-weight trucks of highways in Nevada that would pass through the Moapa and Las Vegas Paiute Indian Reservations.

## 2.5 Collection of Information and Analyses

DOE conducted a broad range of studies to obtain or evaluate the information needed for the assessment of Yucca Mountain as a monitored geologic repository for spent nuclear fuel and high-level radioactive waste. The Department used the information from these studies in the analyses described in this EIS. Because some of these studies are ongoing, some of the information is incomplete.

**Table 2-10.** Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 1 of 2).

Impact	Mostly rail with branch rail					Mostly legal-weight truck
	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	
<i>Corridor length (kilometers)</i>	512 - 553	514 - 544	344 - 382	181 - 204	159 - 163	230 - 270
<i>Land use and ownership</i>						
Disturbed land (square kilometers) <sup>a</sup>	18 - 20	19 - 20	13 - 14	9.2 - 10	5 - 5.2	0
Private land (square kilometers)	0.9 - 2.5	7.3 - 15	0.8 - 1.1	0.1 - 3.5	0 - 0.18	0
Nellis Air Force Range land (square kilometers)	0 - 11	0 - 11	22	0	3.6 - 7.5	0
Tribal	0 - 1.6	0 - 1.6	0	0	0	0
<i>Air quality</i>						
PM <sub>10</sub> and carbon monoxide (construction and operations)	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Except in Clark County, areas in attainment of air quality standards - branch rail line not a significant source of pollution	Clark County is in nonattainment of air quality standards for PM <sub>10</sub> - branch rail line construction could be a significant source of pollution <sup>b</sup>	Not a significant source of pollution
<i>Hydrology</i>						
Surface water	Low	Low	Low	Low	Low	None
Surface water resources along route	5	6	3	0	0	NA <sup>d</sup>
Flood zones	9	11	At least 3	7	2	NA
<i>Groundwater</i>						
Water use (acre-feet) <sup>c</sup>	710	660	480	410	320	0
Water use (number of wells)	64	67	43	23	20	0
<i>Biological resources and soils</i>						
Low	Low	Low	Low	Low	Low	Very low
<i>Cultural resources</i>						
None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological or historical resources. Route passes close to the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
<i>Noise</i>						
Moderate	Moderate	Low	Moderate	Moderate	Moderate	Low
<i>Utilities and resources</i>						
Diesel (million liters) <sup>e</sup>	45	41	36	30	14	Very low
Gasoline (thousand liters)	940	840	680	570	280	
Steel (thousand metric tons) <sup>f</sup>	78	75	52	29	23	0
Concrete (thousand metric tons) <sup>g</sup>	460	420	310	170	130	0

**Table 2-10.** Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 2 of 2).

Impact	Mostly rail with branch rail					Mostly legal-weight truck
	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	
<i>Aesthetics</i>	Very low	Very low	Very low	Potential small area of conflict	Very low	None
<i>Socioeconomics</i>						
New jobs (percent of workforce in affected counties)	840 (< 1% - 3.2%)	780 (< 1%)	650 (<1% - 2.3%)	530 (< 1%)	250 (< 1%)	Very low
Peak real disposable income (million dollars)	24	21	19	15	7	Very low
Peak incremental Gross Regional Product (million dollars)	40	36	31	26	13	Very low
<i>Waste management</i>	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Very low
<i>Environmental justice (disproportionately high and adverse impacts)</i>	None	None	None	None	None	None
<i>Incident-free health and safety</i>						
<i>Industrial hazards</i>						
Total recordable incidents	220	200	180	150	110	NA
Lost workday cases	110	100	90	80	60	NA
Fatalities	0.43	0.41	0.38	0.3	0.25	NA
Collective dose (person-rem [LCFs])						
Workers	850 [0.34]	980 [0.39]	740 [0.3]	760 [0.3]	710 [0.28]	1,900 [0.75]
Public	19 [0.009]	38 [0.019]	50 [0.025]	130 [0.06]	23 [0.012]	340 [0.17]
Fatalities from vehicle emissions	0.25	0.25	0.2	0.23	0.13	0.086
<i>Accident impacts, nonradiological traffic</i>						
Construction and operations workforce	1.9	1.8	1.5	1.2	0.9	NA
SNF <sup>h</sup> and HLW <sup>i</sup> shipping	0.07	0.09	0.05	0.06	0.05	0.49
<i>Accident impacts, radiological</i>						
<i>Radiological accident risk</i>						
Person-rem	0.002	0.003	0.002	0.007	0.002	0.053
Latent cancer fatalities	0.0000009	0.0000013	0.0000009	0.0000036	0.000001	0.000026
Maximum reasonably foreseeable accident						
Maximally exposed individual (rem)	29	29	29	29	29	0.3
Individual latent cancer fatality probability	0.014	0.014	0.014	0.014	0.014	0.0015
Collective dose (person-rem)	9,900	9,900	9,900	9,900	9,900	1,100
Latent cancer fatalities	4.9	4.9	4.9	4.9	4.9	0.55

- Convert square kilometers to acres, multiply by 247.1.
- To convert acre-feet to gallons, multiply by 325,850.1.
- To convert liters to gallons, multiply by 0.26418.
- To convert metric tons to tons, multiply by 1.1023.
- To convert cubic feet to cubic meters, multiply by 0.028317.
- NA = not applicable.
- SNF = spent nuclear fuel.
- HLW = high-level radioactive waste.
- Conformity analysis may be required (see Chapter 3, Sections 3.1.2.1 and 3.2.2.1.2).

**Table 2-11.** Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 1 of 3).

Impact	Mostly rail with heavy-haul truck					Mostly legal-weight truck
	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	
<i>Corridor length (kilometers)</i>	530	280	380	190	180	230 - 270
<i>Land use and ownership</i>						
Disturbed land (square kilometers) <sup>a</sup>	3.4	1.3	2.1	0.63	0.63	0
Private land (square kilometers)	0	0	0	0	0	0
Nellis Air Force Range land (square kilometers)	0	0	0	0	0	0
<i>Air quality</i>						
PM <sub>10</sub> and carbon monoxide (construction and operations)	Areas in attainment of air quality standards - not a significant source of pollution	Areas in attainment of air quality standards - not a significant source of pollution	Clark County is in nonattainment of air quality standards - heavy-haul route construction could be a significant source of pollution <sup>b</sup>	Except in Clark County, areas in attainment of air quality standards - not a significant source of pollution	Except in Clark County, areas in attainment of air quality standards - not a significant source of pollution	Not a significant source of pollution
<i>Hydrology</i>						
Surface water	Low	Low	Low	Low	Low	None
Groundwater						
Water use (acre-feet) <sup>c</sup>	100	60	44	8	8	0
Water use (number of wells)	16	5	7	Truck water	Truck water	0
<i>Biological resources and soils</i>	Low	Low	Low	Low	Low	Very low
<i>Cultural resources</i>	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources; route near Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; route passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; IMT <sup>d</sup> and route near the Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
<i>Noise</i>	Low	Low	Low	Low	Low	Low
<i>Utilities and resources</i>						
Diesel (million liters) <sup>e</sup>	13	4.7	5.5	1.7	1.6	Very low
Steel (metric tons) <sup>f</sup>	49	14	21	2.3	2.3	0
Concrete (thousand metric tons) <sup>g</sup>	1.8	0.5	0.8	0.1	0.1	0
<i>Aesthetics</i>	Some potential near Caliente	Some potential near Caliente	Some potential near Caliente	Very low	Very low	None

**Table 2-11.** Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 2 of 3).

Impact	Mostly rail with heavy-haul truck					Mostly legal-weight truck
	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	
<i>Socioeconomics</i>						
New jobs (percent of workforce in affected counties)	860 (< 1% - 3.3%)	750 (< 1% - 4.9%)	590 - 1,980 (< 1% - 3.3%)	630 - 3,050 (< 1%)	490 - 1,880 (< 1%)	Very low
Peak real disposable personal income (million dollars)	27	22	19 - 65	21 - 97	16 - 62	Very low
Peak incremental Gross Regional Product (million dollars)	45	40	33 - 104	36 - 153	29 - 100	Very low
<i>Waste management</i>	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Very low
<i>Environmental justice (disproportionately high and adverse impacts)</i>	None	None	None	None	None	None
<i>Incident-free health and safety</i>						
Industrial hazards						
Total recordable incidents	310	270	260	150	150	NA <sup>b</sup>
Lost workday cases	160	140	140	80	80	NA
Fatalities	0.72	0.68	0.63	0.37	0.37	NA
Collective dose (person-rem [LCFs])						
Workers	1,600 [0.65]	1,200 [0.50]	1,400 [0.56]	1,200 [0.48]	1,100 [0.46]	1,900 [0.75]
Public	76 [0.038]	61 [0.030]	220 [0.11]	300 [0.15]	160 [0.08]	340 [0.17]
Fatalities from vehicle emissions	0.47	0.32	0.46	0.42	0.29	0.086
<i>Accident impacts, nonradiological traffic</i>						
Construction and operations workforce	3.5	2.4	3.0	1.7	1.7	NA
SNF <sup>i</sup> and HLW <sup>j</sup> shipping	0.6	0.33	0.43	0.25	0.23	0.49
<i>Accident impacts, radiological</i>						
Radiological accident risk						
Person-rem	0.01	0.002	0.056	0.12	0.056	0.053
Latent cancer fatalities	0.0000051	0.000001	0.000028	0.00006	0.000028	0.000026

**Table 2-11.** Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 3 of 3).

Impact	Mostly rail with heavy-haul truck					Mostly legal-weight truck
	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	
Maximum reasonably foreseeable accident						
Maximally exposed individual (rem)	29	29	29	29	29	3
Individual latent cancer fatality probability	0.014	0.014	0.014	0.014	0.014	0.0015
Collective dose (person-rem)	9,900	9,900	9,900	9,900	9,900	1,100
Latent cancer fatalities	4.9	4.9	4.9	4.9	4.9	0.55

- a. To convert square kilometers to acres, multiply by 247.1.  
b. To convert acre-feet to gallons, multiply by 325,850.1.  
c. IMT = intermodal transfer.  
d. To convert liters to gallons, multiply by 0.26418.  
e. To convert metric tons to tons, multiply by 1.1023.  
f. To convert cubic feet to cubic meters, multiply by 0.028317.  
g. NA = not applicable.  
h. SNF = spent nuclear fuel.  
i. HLW = high-level radioactive waste.  
j. Conformity analysis may be required (see Chapter 3, Sections 3.1.2.1 and 3.2.2.1.2).

The complexity and variability of the natural system at Yucca Mountain, the long periods evaluated, and factors such as the use of incomplete information or the unavailability of information have resulted in a certain degree of uncertainty associated with the analyses and findings in this EIS. DOE believes that it is important that the EIS identify the use of incomplete and unavailable information and uncertainty to enable an understanding of its findings. It is also important to understand that research can produce results or conclusions that might disagree with other research. The interpretation of results and conclusions has resulted in the development of views that differ from those that DOE presents in this EIS. DOE has received input from a number of organizations interested in the Proposed Action or No-Action Alternative or from potential recipients of impacts from those actions. These organizations include among others the State of Nevada, local governments, and Native American tribes. Their input includes documents that present research or information that in some cases disagrees with the views that DOE presents in this EIS. The Department reviewed these documents and evaluated their findings for inclusion as part of the EIS analyses. If the information represents a substantive view, DOE has made every effort to incorporate that view in the EIS and to identify its source.

### **2.5.1 INCOMPLETE OR UNAVAILABLE INFORMATION**

Some of the analyses in this EIS had to use incomplete information. To ensure an understanding of the status of its information, DOE has identified the use of incomplete information or the unavailability of information in the EIS in accordance with the Council on Environmental Quality regulations pertaining to incomplete and unavailable information (40 CFR 1502.22). Such cases describe the basis for the analyses, including assumptions, the use of preliminary information, or conclusions from draft or incomplete studies. DOE continues to study issues relevant to understanding what could happen in the future at Yucca Mountain and the potential impacts associated with its use as a repository. As a result, this Final EIS includes information that was not available for the Draft EIS. DOE believes that sufficient information is currently available to assess the range of impacts that could result from either the Proposed Action or the No-Action Alternative.

### **2.5.2 UNCERTAINTY**

The results and conclusions of analyses often have some associated uncertainty. The uncertainty could be the result of the assumptions used, the complexity and variability of the process being analyzed, the use of incomplete information, or the unavailability of information. To enable an understanding of the status of its findings, this EIS contains descriptions of the uncertainties, if any, associated with the results and conclusions presented. Chapter 5, Section 5.2.4 provides further description of uncertainties associated with estimating long-term impacts.

### **2.5.3 OPPOSING VIEWS**

In this EIS, opposing views are defined as differing views or opinions currently held by organizations or individuals outside DOE. These views are considered to be opposing if they include or rely on data or methods that DOE is not currently using in its own impact analysis. In addition, these views are reasonably based on scientific, regulatory, or other information supported by credible data or methods that relate to the impacts analyzed in the EIS.

DOE has attempted to identify and address the range of opposing views in this EIS. The Department identified potential opposing views by reviewing public comments received during the EIS comment period, as well as, published or other information in the public domain. Sources of information included reports from universities, other Federal agencies, the State of Nevada, counties, municipalities, other local

governments, and Native American tribes. DOE reviewed the potential opposing views to determine if they:

- Address issues analyzed in the EIS
- Differ from the DOE position
- Are based on scientific, regulatory, or other information supported by credible data or methods that relate to the impacts analyzed in the EIS
- Have significant basic differences in the data or methods used in the analysis or to the impacts described in the EIS

DOE has included potential opposing views that met the above criteria in the EIS where it discusses the particular subject. For example, opposing views on the groundwater system are discussed in the sections on groundwater.

#### **2.5.4 PERCEIVED RISK AND STIGMA**

During the scoping process for the Draft EIS, commenters requested DOE to evaluate the potential impacts that could arise from risk perception and stigma associated with the construction and operation of a repository at Yucca Mountain and from the transportation of spent nuclear fuel and high-level radioactive waste. Commenters stated that negative perceptions of the repository and associated transportation would result in substantial adverse socioeconomic impacts, particularly in Nevada.

In considering the request to evaluate the impacts of risk perception and stigma, DOE recognized that nuclear facilities can be perceived to be either positive or negative, depending on the underlying value systems of the individual forming the perception. Thus, perception-based impacts would not necessarily depend on the actual physical impacts or risk of repository operations, including transportation. A further complication is that people do not consistently act in accordance with negative perceptions, and thus the connection between public perception of risk and future behavior would be uncertain or speculative at best. For these reasons, DOE concluded that including analyses of perception-based and stigma-related impacts in the Draft EIS would not provide meaningful information.

Comments on the Draft EIS and Supplement to the Draft EIS once again raised the issue of risk perception and stigma. In response, DOE examined relevant studies and literature on perceived risk and stigmatization of communities to determine whether the state of the science in predicting future behavior based on perceptions had advanced sufficiently since scoping to allow DOE to quantify the impact of public risk perception on economic development or property values in affected communities. Of particular interest were those scientific and social studies carried out in the past few years that directly relate to either Yucca Mountain or to DOE actions, such as the transportation of foreign research reactor fuel (see Appendix N). DOE also reexamined the conclusions of previous literature reviews, such as that conducted in 1995 by the Nuclear Waste Technical Review Board.

##### **PERCEIVED RISK AND STIGMA**

DOE uses the term risk perception to mean how an individual perceives the amount of risk from a certain activity. Studies show that perceived risk varies with certain factors, such as whether the exposure to the activity is voluntary, the individual's degree of control over the activity, the severity of the exposure, and the timing of the consequences of the exposure.

DOE uses stigma to mean an undesirable attribute that blemishes or taints an area or locale.

After completing its review, DOE concluded that, although public perception regarding the proposed geologic repository and transportation of spent nuclear fuel and high-level radioactive waste could be measured, there is no valid method to translate these perceptions into quantifiable economic impacts. Researchers in the social sciences have not found a way to reliably forecast linkages between perceptions or attitudes reported in surveys and actual future behavior. Based on the current limitations in forecasting future behavior attributable to risk perception or stigma, there is a consensus among social scientists that a quantitative assessment of economic impacts from risk perception and stigma is impossible at this time. At best, only a *qualitative* assessment is possible about what broad outcomes seem most likely.

Qualitatively, in the absence of a large accident or a continuing series of smaller accidents, there is little reason to expect that negative perceptions about repository operations are likely to engender adverse effects (see Appendix N). Likewise, absent accidents, there is no reason to expect that risk perceptions would impact property values in areas beyond the transportation corridors. Some studies (DIRS 156055- UER 2001, all; DIRS 156003-Gawande and Jenkins-Smith 2001, all) report that, at least temporarily, a small relative decline in residential property values might result from the designation of transportation corridors in urban areas, even in the absence of accidents. Other transportation experiences (for example, transportation of *transuranic waste* to the Waste Isolation Pilot Plant) suggest that impacts on property values might be negligible or nonexistent.

Based on the general research to date on perceptions and future behavior, and research related specifically to a Yucca Mountain repository, other nuclear facilities, and transportation of spent nuclear fuel and high-level radioactive waste, DOE has concluded that:

- While in some instances risk perceptions could result in adverse impacts on portions of a local economy, there are no reliable methods whereby such impacts could be quantified with any degree of certainty.
- Much of the uncertainty is irreducible.
- Based on a qualitative analysis, adverse impacts from perceptions of risk would be unlikely or relatively small.

While stigmatization of southern Nevada can be envisioned under some scenarios, it is not inevitable or numerically predictable. Any such stigmatization would likely be an aftereffect of unpredictable future events, such as serious accidents, which may not occur. Consequently, DOE did not attempt to quantify any potential for impacts from risk perceptions or stigma in this EIS.

The studies and literature reviewed are referenced in a report included in Appendix N, *Are Fear and Stigmatization Likely, and How Do They Matter? Lessons from Research on the Likelihood of Adverse Socioeconomic Impacts from Public Perceptions of the Yucca Mountain Repository* by Dr. Robert O'Connor.

## 2.6 Preferred Alternative

DOE's preferred alternative is to proceed with the Proposed Action to construct, operate and monitor, and eventually close a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. The analyses in this EIS did not identify any potential environmental impacts that would be the basis for not proceeding with the Proposed Action. Further, DOE has identified mostly rail as its preferred mode of transportation, both nationally and in the State of Nevada.